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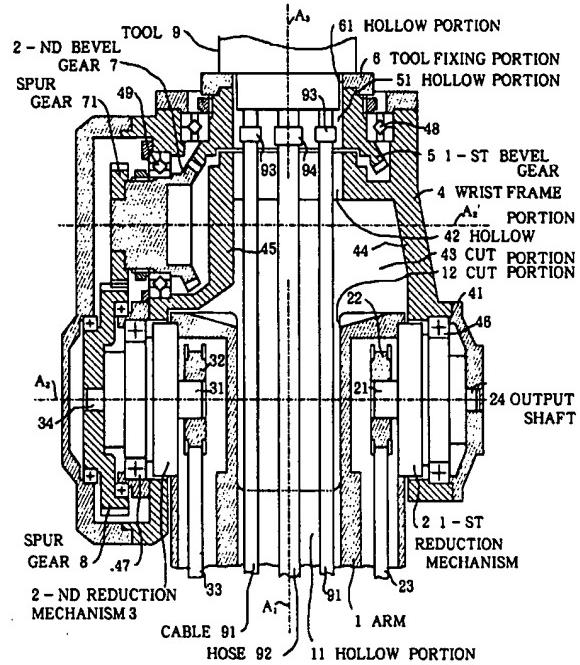
㉜ WRIST STRUCTURE FOR INDUSTRIAL ROBOTS.

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㉝ A wrist structure is provided with first and second reduction gears (2, 3) which have a second shaft perpendicularly crossing a first shaft extending in the lengthwise direction of an arm (1), and a third shaft perpendicularly crossing the second shaft, and which are supported on both sides of a free end portion of the arm (1), which has a hollow (11), in such a manner that the first and second reduction gears can be rotated around the second shaft; a wrist frame (4) fixed to the output shaft (24) of the first reduction gear (2) and having a hollow (42); a first bevel gear (5) which is supported so that it can be rotated around the third shaft perpendicularly crossing the

second shaft provided on the wrist frame (4), and which has a hollow (51); a second bevel gear (7) which is rotatable around a shaft parallel to the second shaft, and which is meshed with the first bevel gear (5); a gear (71) combined unitarily with the second bevel gear (7); a gear (8) mounted fixedly on the output shaft (34) of the second reduction gear (3) and meshed with the gear (71); and a tool fixing member (6) fixed to the first bevel gear (5) and having a hollow (61). Accordingly, cable and hose connecting operations can be carried out easily, and the time required for such operations can be reduced.

Fig. 1



[Technical Field]

This invention relates to a wrist mechanism provided at the front end portion of the arm of an industrial robot.

[Background Art]

Hitherto, there is disclosed a wrist mechanism comprises, at the front end portion of the arm of an industrial robot, a rotary shaft rotating about a second axis perpendicular to a first axis extending in a length direction of the arm and a rotary shaft rotating about a third axis perpendicular to the second axis, wherein two drive mechanisms for independently driving the second and third axes are provided, thus to rotate a tool fixing portion through a bevel gear about the second and third axes (e.g., Jikkaisho No. 63-70896 (Japanese Utility Model Application Laid Open No. 70896/1988).

Moreover, there is disclosed a wrist mechanism in which an arm is formed by three shafts of the hollow structure in a concentrical form, an inclined rotary portion in a hollow form rotating through a hollow bevel gear about a second axis inclined relative to a first axis extending in a length direction of the arm is provided at the front end portion thereof, and a hollow tool fixing portion rotating through a bevel gear about a third axis inclined relative to the second axis is provided (e.g., Tokkaisho No. 61-168487 (Japanese Patent Application Laid Open No. 168487/1986).

However, in the prior art of the Jikkaisho No. 63-70896, since the front end portion of the arm is occupied by two drive mechanisms for independently driving the second and third axes, cable and hose for supplying electricity and fluid such as pressurized oil or pressurized air, etc. cannot be passed through the tool fixed at tool fixing portion, and such cable and hose are therefore disposed outside the wrist portion. For this reason, there was the problem that in the case where the wrist portion is rotated many number of times, cable or hose is wound around the wrist portion, so the rotational operation range of the wrist portion is limited.

Moreover, in the prior art of the Tokkaisho No. 61-168487, since while cable or hose can be passed through the hollow arm, it is necessary to pass such cable or hose inside three hollow bevel gears of the wrist portion and the hollow passage is curved, there was the problem that at the time of work for attachment/detachment of cable or hose, tool is detached from the tool fixing portion and connector is then detached, so it would take much time.

[Disclosure of the Invention]

An object of this invention is to provide a wrist mechanism of an industrial robot in which there is no possibility that rotational operation of the wrist portion is limited, and work for attaching/detaching cable or hose for tool is facilitated.

This invention is directed to a wrist mechanism of an industrial robot having a second axis perpendicular to a first axis extending in a length direction of an arm and a third axis perpendicular to the second axis, and including a wrist portion capable of rotating about the second and third axes, the wrist mechanism comprising: first and second reduction mechanisms supported at both side surface portions of the front end portion of the arm having a cut portion so that they can be rotated about the second axis; a wrist frame including a hollow portion and a cut portion fixed at the output shaft of the first reduction mechanism; a first bevel gear including a hollow portion provided at the wrist frame and supported so that it can be rotated about the third axis perpendicular to the second axis; a second bevel gear provided at the wrist frame, rotating about an axis in parallel to the second axis, and meshing with the first bevel gear; a toothed wheel integral with the second bevel gear; a toothed wheel fixed at the output shaft of the second reduction mechanism and meshing with the toothed wheel integral with the second bevel gear; and a tool fixing portion including a hollow portion, fixed at the first bevel gear.

Particularly, cable and hose connected to tool are provided in the state passed through the hollow portion and the cut portion of the arm, the hollow portion and the cut portion of the wrist frame, and the hollow portion of the first bevel gear.

For this reason, cable and hose are permitted to be passed through space substantially linearly formed from the hollow portion of the arm up to the tool fixing portion via the cut portion, and hand is inserted from the side surface into the cut portion of relatively broad space of the wrist frame, thus making it possible to carry out connecting work.

Accordingly, in accordance with this invention, it is possible to process cable or hose for tool within the wrist portion and multi-rotation of the wrist can be made. In addition, works for connecting cable and hose are facilitated, thus making it possible to reduce connecting work hours.

[Brief Description of the Drawing]

FIG. 1 is a side cross sectional view showing an embodiment of this invention.

[Best Mode for Carrying Out the Invention]

This invention will now be described in accordance with the embodiment shown.

FIG. 1 is a side cross sectional view showing the embodiment of this invention. In the figure, reference numeral 1 denotes an arm including hollow portion 11 and cut portion 12 at one end thereof, and first reduction mechanism (gears) 2 and second reduction mechanism (gears) 3 rotating about second axis A₂ perpendicular to first axis A₁ extending in a length direction of arm 1 are provided at both side surfaces with cut portion 12 at one end being put therebetween. Pulleys 22 and 32 are respectively fixed at input shafts 21, 31 of the first and second reduction mechanisms 2 and 3, and these reduction mechanisms are respectively driven by two drive motors provided at the other end (not shown) of arm 1 through timing belts 23 and 33 wound on pulleys 22 and 32.

At output shaft 24 of first reduction mechanism 2, side surface portions 44, 45 of the both sides of wrist frame 4 provided with hollow portion 42 and cut portion 43 through bearing cover 41 are fixed. Moreover, at fixed portions of the first and second reduction mechanism 2 and 3, wrist frame 4 is supported through bearings 46 and 47 so that it can be rotated about second axis A₂. By rotating output shaft 24 of first reduction mechanism 2, wrist frame 4 is rotated about the second axis A₂ through bearing cover 41.

At the end portion of wrist frame 4, first bevel gear 5 in a hollow form supported so that it can be rotated about the third axis A₃ perpendicular to the second axis A₂ is provided. At the first bevel gear 5, tool fixing portion 6 in a hollow form rotating concentrically with the first bevel gear 5 is fixed. Moreover, at the wrist frame 4, there are provided second bevel gear 7 rotating about axis A_{2'} in parallel to the second axis A₂ through bearing 49 and supported so as to mesh with the first bevel gear 5 and spur gear 71 concentrical with the second bevel gear 7 and rotating in one body therewith.

At output shaft 34 of second reduction mechanism 3, spur gear 8 meshing with the spur gear 71 is fixed. By rotating the output shaft 34, tool fixing portion 6 can be rotated about the third axis A₃ through spur gears 8, 71, and first and second bevel gears 5 and 7.

Tool 9 is fixed at tool fixing portion 6. Connectors 93, 94 of power supply cables 91 and fluid supply hose 92 connected to the tool 9 are projected from hollow portion 61 of tool fixing portion 6 to hollow portion 51 of first bevel gear 5. Cables 91 and hose 92 are passed through hollow portion 42 of wrist frame 4 from hollow portion 11 of arm 1 and are connected to connectors 93, 94.

As stated above, since cables 91 and hose 92 can be passed through space substantially linearly formed from hollow portion 11 and cut portion 12 of arm 1 up to tool fixing portion 6, and hand is inserted from the side surface of wrist frame 4 into cut portion 43 thus to permit implementation of connecting work at cut portion 43 of relatively broad space, there is no necessity of detaching tool from tool fixing portion 6. Thus, work for attaching/detaching cable or hose is facilitated.

[Industrial Applicability]

This invention can be utilized in the field for manufacturing and providing wrist mechanism provided at the front end portion of arm of industrial robot in which, when applied to wrist mechanism provided at the front end portion of arm of industrial robot, cable or hose for tool can be processed within the wrist portion, multi-rotation of wrist portion can be carried out, connecting work of cable and hose is easy, and connecting time can be reduced.

25 **Claims**

1. An industrial robot having a second axis perpendicular to a first axis extending in a length direction of an arm and a third axis perpendicular to the second axis, and including a wrist portion capable of rotating about the second and third axes, the wrist mechanism comprising: first and second reduction mechanisms supported at both side surface portions of the front end portion of the arm having a cut portion so that they can be rotated about the second axis; a wrist frame including a hollow portion and a cut portion fixed at the output shaft of the first reduction mechanism; a first bevel gear including a hollow portion provided at the wrist frame and supported so that it can be rotated about the third axis perpendicular to the second axis; a second bevel gear provided at the wrist frame, rotating about an axis in parallel to the second axis, and meshing with the first bevel gear; a toothed wheel integral with the second bevel gear; a toothed wheel fixed at the output shaft of the second reduction mechanism and meshing with the toothed wheel integral with the second bevel gear; and a tool fixing portion including a hollow portion, fixed at the first bevel gear.
2. A wrist mechanism of an industrial robot as set forth in claim 1, wherein a cable and a hose connected to a tool are provided in the state passed through the hollow portion and the cut portion of the arm, the hollow portion and the

cut portion of the wrist frame, and the hollow portion of the first bevel gear.

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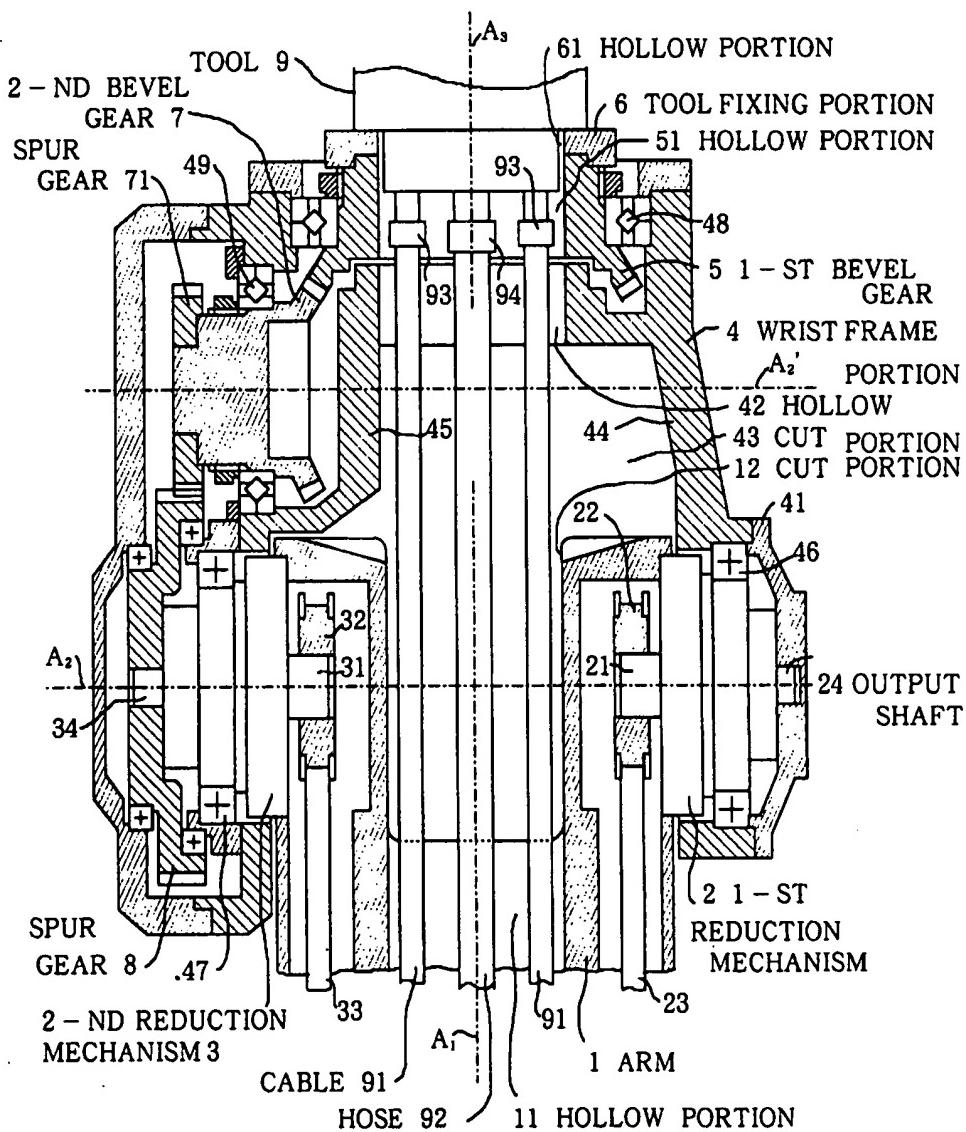
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Fig. 1



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP94/00709

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl ⁵ B25J17/02		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
Int. Cl ⁵ B25J17/02, 19/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Jitsuyo Shinan Koho 1926 - 1994 Kokai Jitsuyo Shinan Koho 1971 - 1994		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, A, 61-56889 (American Robot Corp.), March 22, 1986 (22. 03. 86) & EP, A1, 172603 & US, A, 4645409 & AT, E, 40312 & CA, A1, 1257887	1-2
Y	JP, A, 59-73297 (Fanuc Ltd.), April 25, 1984 (25. 04. 84) & WO, A1, 8401538 & EP, A1, 122295 & US, A, 4626165	1-2
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
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